REPORT ON

CRACKED HEAT EXCHANGERS

IN GAS FURNACES

Ontario

Ontario Ministry of Housing
Technical Support Services Branch

REPORT ON
CRACKED HEAT EXCHANGERS IN GAS FURNACES

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A. PURPOSE

To report on cracked heat exchangers in residential gas furnaces involving the following topics:

1. Concerns about health hazards.

2. Method(s) of checking for cracked heat exchangers.

3. Create a database (from the housing authorities and other sources) of various models of furnaces encountering this problem prematurely. This would be used for reference purposes.

B. INTRODUCTION

Minor cracks can occur in heat exchangers without creating a life hazard. A minor crack can, on occasion, progressively deteriorate to a major defect. However, even in these extreme cases, it will take some form of vent blockage and/or flame distortion to create the conditions for a life hazard.

A colorless, odorless byproduct of combustion, carbon monoxide can leak into homes undetected. Some cracking that occurs during the heating season, after the furnace inspection, can be spotted if the tenant reports fumes or smells in the house or experiences symptoms of poisoning, including dizziness, nausea, headaches, stomach upset, drowsiness and weakness. By-products of combustion can be lethal.

Because of the negative pressures often present inside heat exchangers, flow products do not always leak out into the warm air.

This is not the case with the Lennox Pulse furnace as there is a positive internal pressure due to pulsating combustion. If this furnace was subject to a leak, the combustion products would spill out. The manufacturer claims that if this occurred, the furnace would shut down.

A survey was conducted of the RHPO's and Housing Authorities to ascertain which furnaces were encountering premature failure of the heat exchangers.

C. CRACKED HEAT EXCHANGERS

(1) Causes of Heat Exchanger Failure

Each gas-fired furnace has a burner compartment containing the gas burner and pilot. The gas and air necessary for combustion are mixed in the venturi or mixing tube prior to ignition. This mixture is then ignited by the pilot flame as it leaves the burner. The burner flame is encased in a combustion chamber or fire box located directly below the furnace heat exchanger. The heat of the combustion process is transferred to the metal walls of the heat exchanger and then to the air rising through it (Fig. 1).

The air flowing through a heat exchanger is subject to temperatures which frequently approach the 700-800°F range. Because of these high temperatures, the air flow must be uniform across all sections of the heat exchanger and must move at a sufficient rate of speed to keep these temperatures from building any higher. A low volume of air flowing across one section of the heat exchanger will result in overheating and the failure of the entire heat exchanger assembly (Fig. 2).

Overheating can also be caused by a portion of the gas flame impinging on the inner surface of the heat exchanger (Fig. 3). This results in the generation of extremely high temperatures. Under normal operating conditions, the gas flame should be directed upward through the centre of each section.

Another cause of heat exchanger failure is over firing. This condition is usually traced to an excessively high manifold pressure or an orifice that is too large. The result is a firing rate that exceeds the design limits.

If the heat exchanger becomes so covered with soot, carbon deposits and other contaminants that it reduces the operating efficiency of the furnace, it should be thoroughly cleaned. Gaining access to the heat exchanger is not easy, because it requires removing the burners and manifold assembly, vent connector, draft hood (diverter) and flue baffles.

Figure 1

Uniform air flow across all sections of the heat exchanger.

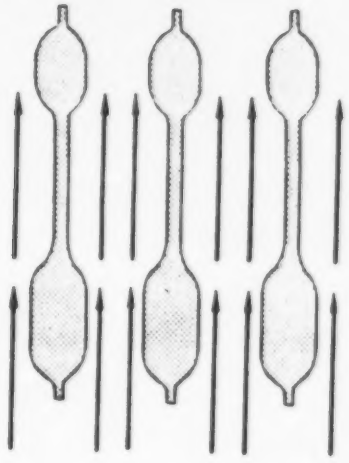


Figure 2

Low air flow across one heat exchanger section may result in premature failure due to overheating.

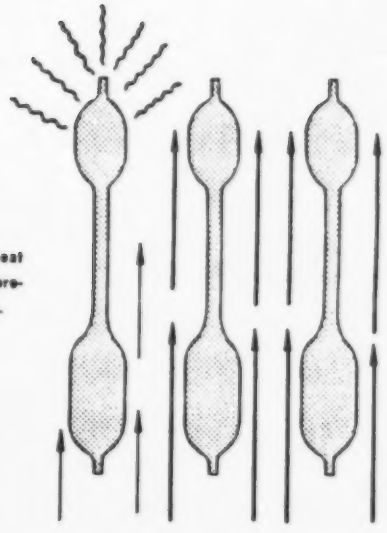
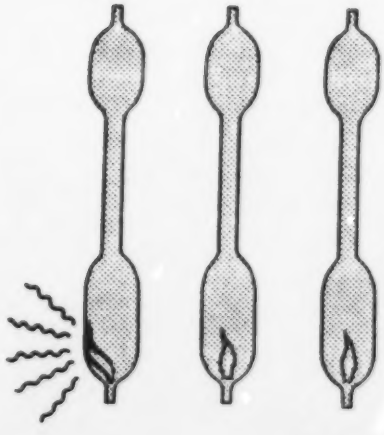


Figure 3

Flame impingement in one section of the heat exchanger.



(2) Checking for Cracks

According to Consumers' Gas, tests for cracked heat exchangers are conducted if:

1. A customer has a service call and the serviceman thinks a test is required.

2. A customer reports fumes or smells.

The methods of checking for cracked heat exchangers in conventional furnaces, as outlined by the Canadian Gas Association are:

(1) Visual Inspection

The heat exchanger must be reasonably clear of rust before checking for leaks.

Utilizing a mirror and a light with the main burner and pilot shut off, inspect the internal section for signs of split seams, open cracks and/or severe deterioration. Special care is to be given to all joints between the flue gas passages of the heat exchanger and other parts of the furnace as well as the heat exchanger and the section of any part of the heat exchanger that is located in the return air compartment.

Ignite the pilot and main burner and observe the flame pattern. Allow the furnace to heat up to bring the blower on automatically. Observe the flame pattern for flame roll-out at the access opening or flame distortion indicating a split seam, open crack and/or severe deterioration of the heat exchanger.

(2) Smoke Test

This test is to be done where a leak is suspected and cannot be found visually or to confirm the results of a visual inspection.

(a) Cold Test -- (Where it is not practical to turn heat on).

Turn off electric power supply to furnace so that blower cannot operate.

If the furnace is at room temperature, turn off the gas supply to the furnace using the manual valve. Block off the furnace flue outlet ahead of the draft diverter with damp rags and set a "smoke bomb" inside the combustion chamber. Seal off the burner access opening with rags, leaving a small opening to allow lighting of the "smoke bomb". Light the "smoke bomb" and quickly seal the rest of the access opening.

Observe whether any smoke or odor is escaping from the heat exchanger by looking through the inspection opening in the plenum, the humidifier opening or through the warm air registers nearest the furnace.

(b) Hot Test -- (Preferred Method)

With a forced air furnace, turn off the electrical supply to the fan motor or remove the fan belt. Bring on the main burner allowing the furnace to cycle on the high limit or operate for a maximum of five (5) minutes. Then turn off the gas supply to the furnace using the manual valve.

Immediately block off the furnace flue outlet ahead of the draft diverter using damp rags. Place a "smoke bomb" inside the combustion chamber and after lighting, quickly seal off the burner access opening with damp rags.

Check the heat exchanger for leaks, that may result in smoke or odour, in the same manner as the cold test.

Note: (i) Liquids shall not be used to check heat exchangers in the field.

(ii) Where part of a heat exchanger extends into the blower compartment or where a heat exchanger is located in the blower compartment a thorough check should be made of this area.

After the test, remove the rags and re-install any parts or components that were removed for the test. Take further appropriate action.

The test principles described above are equally suitable for checking oil furnace heat exchangers.

Note: (i) Union Gas has found that in some cases because of the location of the splits, cracks, holes, etc., or due to the smoke density, some defects may not show up even though they are quite severe.

Thus, an improved method used by Union Gas, for both the cold and hot test, involves the use of tubing and blowing into the combustion chamber to pressurize the chamber.

(ii) The density and volume of smoke produced by the discharge type smoke candles makes it essential that extra precautions are taken to adequately seal the inlet and outlet openings of the furnace being tested. It is equally important to properly bleed the smoke out of the chamber at the test completion to minimize the amount of escapement into the household. The smoke will remain in suspension 10-15 minutes and therefore it is recommended that only the chamber outlet be unblocked at first. When most of the smoke has dissipated, remove the rags from the chamber inlet.

It should be kept in mind that smoke is relatively harmless but all smoke is irritating to nasal and bronchial passages. Exposure without a mask should be limited. Any irritation caused by the smoke is temporary and quickly disappears after exposure has ceased.

Service personnel can also conduct a series of air analyses to detect the presence of combustion products in the house atmosphere. A visual inspection and/or a smoke test should be the primary methods of checking for cracked heat exchangers. The air analysis method should only be done when the other two methods are not practical or possible to conduct. The air analysis test should be done only as a last resort. The test detects combustion products, not heat exchanger cracks. Basically, it compares the concentrations of carbon dioxide and carbon monoxide in the home atmosphere with those in the furnace plenum.

D. RECOMMENDATIONS

The following recommendations are put forward:

1. Follow a plan to identify the make and model of furnaces in projects.

2. If a furnace listed in Appendix 1, Table 1, is found, ascertain its age. Those 15 years or older should be replaced. Refer to:

   Interim Report on the Replacement of (Not Serviceable or Old) Forced Air Residential Gas or Oil Furnaces; Ministry of Housing, Technical Support Services Branch, April 1988.

   Those furnaces less than 15 years old should be checked by gas company servicemen/contractors for cracked heat exchangers. If the heat exchanger is found to be cracked, replace the furnace. Those furnaces which are not found to be defective should be checked by gas company servicemen/contractors before each heating season.

APPENDIX 1

TABLE 1 - DATABASE OF CRACKED HEAT EXCHANGERS IN GAS FURNACES

Furnace Manufacturer	Model Number	No.of Furnaces	Year Furnace Installed	Age of Heat Exchanger When Cracked (Years)	
Anthes	G48100S	1 *		15	
	HGB50	72 *	1970-71	15-17	
	HGB60	3 *		15	
	HGB75	2 *		15	
	HGB85	308 *	1968	15-18	
	HGB90	24 *			
	HGC				
	LGB85	4 *		15	
	LGC				
Chrysler Airtemp		20 *	1968-72	11-15	- See Append. 2
Clare	PG75HBM	2 *	1975	11	
	PG100HBM	2 *	1975	11	
Inter City Mfg.	110CLB	1 *	1973	14	
Keeprite	KGNF090NE	4 *	1968	19	
Preston		1	1981	7	
Heat Controller Inc.	Century & Comfort Aire Reclaimer I				
Trane CAC Inc.	Elite				
Gen. Electric	Elite		1982-85		- See Append. 3
Arco Comfort Products Co.	Arcoaire				
Climate Control Products	Comfort-maker				
Arkla Industries Inc.	Recuper-ative I				

Notes: (1) Conventional furnaces (heat exchangers) have a life expectancy of approximately twenty years.

* Reported by Housing Authorities

...furnace problem spreads ... DAILY COMMERCIAL NEWS

More cracked heat exchangers found

TORONTO (CP)—A potentially-dangerous fault discovered in gas furnaces in a Milton subdivision may be more widespread than initially thought.

Residents in Brantford and the Hamilton suburb of Dundas, say cracks found in the heat exchangers of Chrysler Airtemp furnaces in Milton have also surfaced in furnaces in their communities.

"This isn't just a localized problem," Brantford resident Jim Sadler said. "This isn't just Milton. It appears to be a problem throughout southern Ontario."

Sadler, maintenance manager of a townhouse development, said a recent gas company inspection of the townhouses revealed 36 of 40 Chrysler Airtemp furnaces had cracked heat exchangers.

"We're at wit's end," he said. "We're stumbling around trying to get prices on the units."

He said his company may have to pay more than $200,000 to replace furnaces in 300 Brantford townhouses.

Gas company officials require the exchangers to be replaced immediately—often within 30 days—because of the risk of carbon monoxide poisoning. If the defective unit isn't replaced, the gas supply to the home will be turned off.

But industry and provincial government officials have urged residents with such furnaces not to panic over the potential safety hazard.

"There has never been a carbon monoxide death caused by a crack in a heat exchanger in this country," said Canadian Gas Association spokesman Herb Wank.

Chrysler Canada has disclaimed responsibility for the furnace, which its subsidiary stopped making in 1974.

Ridler Central Refrigeration—the company that took over the warranty—maintains it has no responsibility if the warranty has expired.

A random poll by Milton residents showed 22 of 60 homeowners in their subdivision had cracked heat exchangers with their Chrysler Airtemp furnaces.

Most replaced the furnace at a cost of between $2,200 and $2,800, either because they were unaware another company had picked up the 10-year warranty when Chrysler sold the business in 1974, or because the warranty had expired.

Wank, the gas association's vice-president of engineering, said the cracks in furnace heat exchangers pose more of a performance problem than a hazard.

Grant Mill, spokesman for the Consumer and Commercial Relations Ministry, said last Friday the province is trying to determine whether the furnace problems are higher than the industry norm.

Dundas resident Margaret Connor wasn't reassured by the report no deaths have been linked to cracked heat exchangers.

"You may yet have some deaths," Connor said last week. "People don't normally think about repairing or replacing their furnaces unless there's a problem with turning the furnace on."

Connor said she discovered her heat exchanger problem in 1983 and had it replaced on warranty.

APPENDIX 2

Daily Commercial News Article

APPENDIX 3

Toronto Sun Article

Furnaces to be fixed due to risk

By MICHAEL CLEMENT
Toronto Sun

Repairs are necessary to 2,000 high-efficiency gas furnaces sold in Canada after 1981 because of a carbon monoxide poisoning risk, the U.S. maker of the furnaces has announced.

Arkla Inc. of Shreveport, Louisiana, and Preway Industries of Evansville, Indiana, said they are taking "corrective action" because their Recuperative 1 furnaces could release deadly carbon monoxide into living areas.

The companies have received 14 complaints from owners about internal corrosion. "Over a period of time, the corrosion may cause the metal in some of the furnace components to deteriorate, and can progress to the point where holes can be created through which carbon monoxide could be released into the home," the company said.

A spokesman for Ontario Consumer Minister Bill Wrye said the matter came up late Friday and and is being investigated.

Company spokesman Steve Harvey said inspections will be started "within the next 30 days. We'll need to train dealers up there first."

The Preway and Arkla companies said they will inspect and fix the furnaces at no charge.

If the corrosion is very severe the furnace may be replaced.

Anyone wanting additional information can call toll free to 800-237-5207.

Approximately June/88

APPENDIX 4

MCCR DIRECTIVE & UNION GAS LTD. POSITION REGARDING CRACKED HEAT EXCHANGERS

1. Ministry of Consumer and Commercial Relations
Fuels Safety Branch

Ontario Gas Bulletin 121 (Residential Heat Exchangers) is the directive for gas companies when they find, during the heating season, a cracked heat exchanger:

"Accordingly, the degree of hazard from a cracked heat exchanger must be established beyond reasonable doubt before the gas is shut off. Such verification shall be performed by a gas fitter trained and authorized for this function by his employer pursuant to section 20 of the Energy Act 1971.

Where it has been determined that an immediate hazard exists, the contractor shall, before shutting off the gas, inform the user in writing, tag the appliance and advise the user regarding arrangements for a supply of temporary heat pending the exchanger replacement.

Within the intent of section 4 of O. Reg 826/82 (Energy Act - Gas Utilization Code) the distributor may elect to provide heat for any remaining portion of the heating season by placing the furnace blower on continuous operation or by temporarily sealing a minor crack by an acceptable procedure. Where this action is taken, the owner shall be informed in writing of the action taken and the distributor shall maintain a follow-up procedure to ensure heat exchanger replacement before the next heating season."

Note: When the new Energy Act is passed into law (approximately in 1989) in Ontario, it will be illegal to repair cracked heat exchangers.

2. Union Gas Ltd.

The company position regarding Ontario Gas Bulletin 121 is:

"Where a split or crack is in such a location that continued safe operation cannot be accomplished by placing the furnace blower on continuous operation or temporarily sealing a minor split or crack with furnace cement or fiberglass tape/compound, welding may be a temporary repair until a new heat exchanger is installed.

Welding is not to be a permanent repair.

Where a customer is granted permission to have a split or cracked heat exchanger welded and a new heat exchanger has not been installed by the end of the heating season, the customer must be notified that the furnace will not be lit up the following fall.

Where a heat exchanger seam is found to be slit at the weld or the weld was improper at the time of manufacture, it may be welded but only by the manufacturer and at the factory.

It would therefore be easier and more economical to replace the heat exchanger."

APPENDIX 5

UNION GAS SERVICE BULLETIN DATED FEBRUARY 5, 1979

RE: Anthes (Inter-City) Furnaces
Models HGB, HGC, LGB, LGC

SUBJECT: (i) Cracking in vertical dividing panel
(ii) Cracking around screw holes behind roll-out plate

(i) Cracking in Vertical Dividing Panel

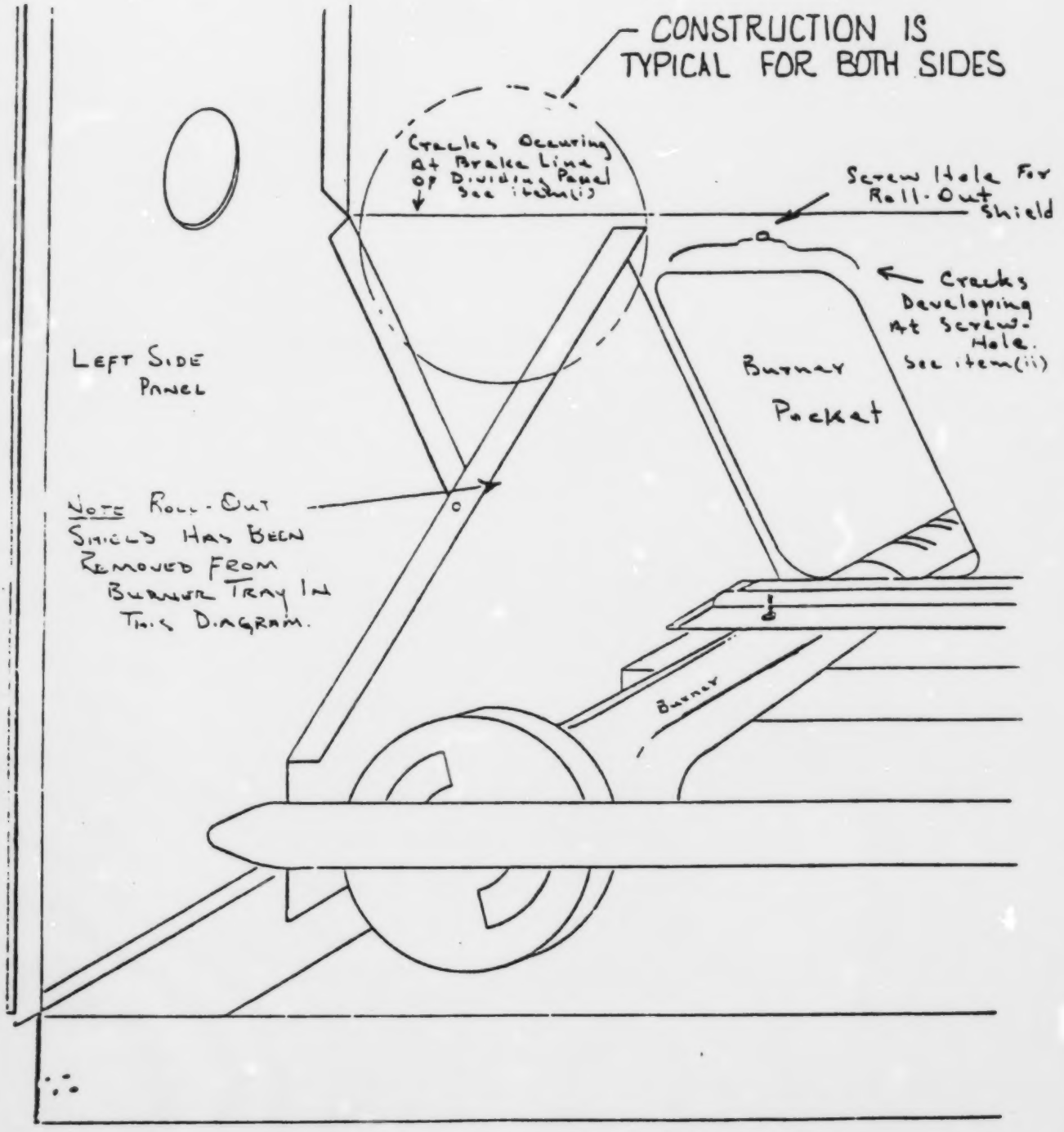
After some field investigation, it has been determined that a flaw can exist on the vertical dividing panel at the brake line where the panel goes from the vertical to the sloped surface (see attached sketch). Thus far, any flaws found are not considered to be a deterrent to the life or safety of the unit and no further corrective action is necessary at this time. However, we would request that these flaws continue to be reported using your normal Problem Report form giving:

Model number and serial number and indicate whether any disturbances to combustion of burner flames are occurring. We may find, with time, repairs or replacement may become necessary.

(ii) Cracks Around Screw Holes Behind Roll-Out Plate

It will be necessary to remove the burner roll-out shield and observe the condition of the dividing panel above the burner pockets in the area of the screw holes (see sketch).

You may notice fractures occurring at the screw holes and continuing around the contour of the burner pocket. Any flaws of this nature must be reported on a Problem Form and the chamber replaced since this crack is located in a combustion products zone and any air leakage may upset complete combustion of the unit.


CONSTRUCTION IS TYPICAL FOR BOTH SIDES
Cracks Occurring At Brake Line Of Dividing Panel See Item(i)
Screw Hole For Roll-Out Shield
Cracks Developing At Screw-Hole. See Item(ii)
LEFT SIDE PANEL
BURNER Pocket
NOTE ROLL-OUT SHIELD HAS BEEN REMOVED FROM BURNER TRAY IN THIS DIAGRAM.
BURNER

APPENDIX 6

CHECKING FOR CRACKED HEAT EXCHANGERS BY TWO METHODS WHICH ARE UNDER DEVELOPMENT

(1) Tracer Gas Test

This method, proposed by the American Gas Association, is currently being tested in the laboratory. It involves injecting a tracer gas into the combustion chamber and then using detection equipment to sense for the tracer gas in the air circulation path. It is a clean method but involves the outlay of approximately $2,000 for the detection equipment and the big bottle of tracer gas which is burdensome to carry.

(2) Analyze Products of Combustion

This method, proposed by the Canadian Gas Research Institute, has been field tested in conjunction with the gas companies. Results which detected cracked heat exchangers were verified by the smoke test.

One person with a portable combustion products analyzer takes approximately 20 minutes to conduct the test.

The furnace is fired up and a reading of the carbon dioxide concentration in the combustion products is taken. An adjustment is made to bring the carbon dioxide level to at least 9%. In naturally vented furnaces, this is done by partially blocking off the combustion air supply.

In power vented furnaces, this is done by partially blocking off the outlet of the exhaust. The carbon dioxide level is recorded again as well as the oxygen level in the flue gases. The furnace is shut down and let to cool down until the blower stops. The furnace is started and before the blower comes on, the oxygen level in the combustion exhaust products is measured. (Normally, the readings are 5% oxygen and 9% carbon dioxide).

After the blower comes on, an oxygen reading is taken (i.e. if a reading of 8% carbon dioxide is taken, this would indicate that more dilution air is introduced). Comparing the two oxygen readings, leakage of any kind in the heat exchanger, including bad welds, is indicated if the oxygen level increases after the blower comes on.

APPENDIX 7

SOURCES OF DATA

(1) Feedback - received from:

1. Northwestern RHPO
2. Southern RHPO
3. Central RHPO
4. Kent & Chatham Housing Authority
5. Wellington & Guelph Housing Authority
6. North Niagara Housing Authority
7. Halton Housing Authority
8. North Waterloo Housing Authority
9. West Kenora District Housing Authority
10. Nipissing & Parry Sound Housing Authority
11. Sudbury Housing Authority

(2) References Used

1. The Billpayer's Guide to Furnace Servicing; Energy, Mines & Resources Canada, August 1980
2. Heating, Ventilating & Air Conditioning Library; James E. Brumbauh
3. Consumers' Gas Co. Ltd.
4. Union Gas Ltd.
5. Canadian Gas Research Institute
6. Heating, Plumbing, Air Conditioning, January/ February 1988.
7. The Daily Commercial News
8. Toronto Sun, June 1988